FOOD HABITS OF THE WESTERN WHIPTAIL LIZARD (*CNEMIDOPHORUS TIGRIS*) IN SOUTHEASTERN NEW MEXICO

Troy L. Best[1] and A. L. Gennaro[2]

ABSTRACT.— This study presents the first food habit assessment for the western whiptail lizard (*Cnemidophorus tigris*) in the shinnery oak–mesquite habitat (*Quercus havardii–Prosopis glandulosa*) of southeastern New Mexico. Short-horned grasshoppers, termites, antlions, beetles, and spiders formed the major portion of the diet during the four-year study. Discriminant analyses were used to evaluate annual, seasonal (monthly), and sexual variation. Incidental food categories were responsible for most of the annual and seasonal variation. Dominant foods varied little between months and years. Sexual variation was more evident; it may act to reduce intraspecific competition for food resources and may be associated with secondary sexual size dimorphism.

Food habits of the western whiptail lizard (*Cnemidophorus tigris*) have been studied in several areas of the western United States (e.g., Pack 1923, Milstead 1957a, 1958, 1961, 1965, Johnson 1966, Echternacht 1967, Medica 1967, Milstead and Tinkle 1969, Pianka 1970, Bickham and MacMahon 1972, Scudday and Dixon 1973, Vitt and Ohmart 1977, Mitchell 1979, Best and Polechla 1983). Some of these investigators have examined intraspecific variation: e.g., Johnson (1966) found that the diet of immature whiptails was similar to that of adults, and Johnson (1966) and Pianka (1970) found little difference in diet between sexes. Conversely, there is considerable geographic (Milstead and Tinkle 1969, Pianka 1970), seasonal (Johnson 1966, Milstead and Tinkle 1969, Pianka 1970, Vitt and Ohmart 1977, Mitchell 1979), and annual variation (Milstead 1965, Medica 1967, Milstead and Tinkle 1969, Mitchell 1979).

In southeastern New Mexico, Best and Polechla (1983) reported diet data for *C. tigris* in their study of *C. gularis*, but their sample of *C. tigris* was small and the habitat where they collected specimens was quite different from where those examined herein were obtained. Subsequently, Best and Gennaro (1984) studied *Uta stansburiana* from the shinnery oak–mesquite habitat of southeastern New Mexico using specimens collected in sympatry with the *C. tigris* reported herein. In view of the previous studies of food habit variation and because no extensive studies of *C. tigris* have been conducted in the shinnery oak–mesquite association of southeastern New Mexico, the present study was initiated. Our objectives were to assemble a listing of food items consumed in that area and to examine annual, seasonal (monthly), and sexual variation.

MATERIALS AND METHODS

From 1976 through 1979, 174 *C. tigris* were collected approximately 40 km E of Carlsbad in Eddy and Lea counties, New Mexico (within an 8-km radius of drill hole ERDA 9, SE corner, Sec. 20, T22S, R31E). Specimens were fixed in 10% formalin and stored in 40% isopropyl alcohol. Stomach contents were later removed, placed into individual vials, and identified. Arthropod taxonomy follows Borror et al. (1981).

Two separate data sets were used in the analyses. One contained the number of individuals in each arthropod order. The second included the number of individuals identified to family except where identification was impossible (e.g., unidentified Coleoptera were entered as Coleoptera, Buprestidae was another character, Cleridae another, etc.). Discriminant analyses (Nie et al. 1975) were used to test for annual, seasonal (monthly), and sexual variation in food habits. Best and Gennaro (1984) presented a summary of this tech-

[1]General College, Department of Biology, and Museum of Southwestern Biology, University of New Mexico, Albuquerque, New Mexico 87131.
[2]Llano Estacado Center for Advanced Professional Studies and Research, Natural History Museum, Eastern New Mexico University, Portales, New Mexico 88130.

TABLE 1. Food items found in 174 western whiptail lizards (*Cnemidophorus tigris*). Sample sizes are given in parentheses and occurrence data are presented as: number of lizards containing a food category; total items observed.

Food category	1976(10)	1977(42)	1978(69)	1979(53)	Combined(174)
Arthropoda				1;1	1;1
ARACHNIDA				1;1	1;1
Scorpionida	1;1	1;1	7;7	5;5	14;14
Araneae		5;8	13;18	13;17	31;43
Solifugae			8;9	3;3	11;12
CHILOPODA		1;1			1;1
HEXAPODA			4;5		4;5
Orthoptera (9)[1]	7;9	32;61	61;146	46;82	146;298
Isoptera (3)		14;299	19;509	23;487	56;1295
Psocoptera (1)			2;2		2;2
Hemiptera (5)	1;1	13;18	2;2	5;5	21;26
Homoptera (5)	2;3	6;14	5;10	1;1	14;28
Neuroptera (2)	1;2	15;22	19;29	4;5	39;58
Coleoptera (9)	4;4	23;62	38;85	13;20	78;171
Lepidoptera (4)	1;1	13;29	20;48	15;22	49;100
Diptera (2)		2;4	7;8	2;2	11;14
Hymenoptera (4)	1;1	7;156	16;24	16;22	40;203
MISCELLANEOUS					
Insect eggs				1;18	1;18
Lizards				2;2	2;2
Sand				2;2	2;2
Empty stomachs				1;1	1;1

[1]Minimum number of families represented.

nique in relation to lizard feeding ecology studies. Analyses were conducted using the IBM computer system at University of New Mexico. Specimens and their stomach contents were deposited in the Eastern New Mexico University Natural History Museum in Portales.

Lizards were collected in a shinnery oak–mesquite association (*Quercus havardii–Prosopis glandulosa*). Although shinnery oak and mesquite did not have the greatest plant density on our study area, they were among the most obvious plant taxa. Extensive vegetation analyses of this noncultivated region are given in Best and Jackson (1982).

RESULTS

Food items found in the stomachs of the 174 *C. tigris* are presented in Table 1. In addition, one platyhelminth was found in July 1978, and 12 nematodes were found in seven 1978 specimens. Arthropods represented by the highest frequencies of occurrence (number of specimens containing a food category/total number of specimens × 100) were: Orthoptera, 84%; Coleoptera, 45%; Isoptera, 32%; and Lepidoptera, 28%. Except for the lack of isopterans in 1976, these categories were represented in each of the four annual samples. Other consistently occurring arthropods were Scorpionida, Hemiptera, Homoptera, Neuroptera, and Hymenoptera. Although the Orthoptera represented at least nine families, there were about 10 times as many Acrididae as any of the others. Their frequency of occurrence was 78%, with 242 acridids being counted. The Coleoptera were more evenly distributed among the nine families identified, but Scarabaeidae, Tenebrionidae, Elateridae, and Curculionidae had 11%–17% frequencies of occurrence, respectively. Other coleopteran families occurred at frequencies less than three percent. In addition, there was an 8% frequency of unidentified coleopterans (18 beetles). There were at least three families of Isoptera; Termitidae was the most common and occurred at a frequency of 4%. Half the lepidopterans were unidentified, and most of the remainder were Geometridae (14% frequency).

The results of the discriminant analysis between years (sexes combined), using the number of arthropods in each order as characters, are shown in Table 2. Only 47% of the *C. tigris* were classified correctly, indicating little difference between years. The analyses using all arthropod taxa (orders, suborders, super families, families) classified 69% of the specimens correctly. In decreasing order of impor-

TABLE 2. Discriminant analyses between years and months for *Cnemidophorus tigris*.

	Actual group	n	Predicted group membership			
Years (1976–1979)[1,2]			1976	1977	1978	1979
	1976	10	7(70.0%)	2(20.0%)	1(10.0%)	0
	1977	42	11(26.2%)	21(50.0%)	7(16.7%)	3(7.1%)
	1978	69	19(27.5%)	7(10.1%)	32(46.4%)	11(15.9%)
	1979	53	19(35.8%)	3(5.7%)	9(17.0%)	22(41.5%)
Months (1977–1979)[3]			May	June	July	August
	May	31	13(41.9%)	8(25.8%)	10(32.3%)	0
	June	60	15(25.0%)	16(26.7%)	25(41.7%)	4(6.7%)
	July	59	6(10.2%)	3(5.1%)	48(81.4%)	2(3.4%)
	August	14	0	1(7.1%)	6(42.9%)	7(50.0%)
Months—1977[4]			May	June	July	
	May	9	5(55.6%)	2(22.2%)	2(22.2%)	
	June	14	1(7.1%)	9(64.3%)	4(28.6%)	
	July	19	2(10.5%)	0	17(89.5%)	
Months—1978[5]			May	June	July	August
	May	14	4(28.6%)	4(28.6%)	6(42.9%)	0
	June	26	4(15.4%)	14(53.8%)	7(26.9%)	1(3.8%)
	July	20	1(5.0%)	1(5.0%)	17(85.0%)	1(5.0%)
	August	9	0	0	4(44.4%)	5(55.6%)
Months—1979[6]			May	June	July	August
	May	8	3(37.5%)	0	5(62.3%)	0
	June	20	2(10.0%)	5(25.0%)	13(65.0%)	0
	July	20	0	0	20(100%)	0
	August	5	0	0	3(60.0%)	2(40.0%)

[1]The data in subsequent footnotes are given as: percent of the specimens that were correctly classified; in decreasing order of importance, the variables accounting for most or all of the differences.
[2]47.1%; Hemiptera, Coleoptera, Orthoptera, Homoptera, Neuroptera, Araneae, Solifugae, Chilopoda, Hexapoda, and lizards.
[3]51.2%; lizards, Lepidoptera, Isoptera, Scorpionida, Coleoptera, Psocoptera, Diptera, Orthoptera, Hemiptera, and Araneae.
[4]73.8%; Lepidoptera, Coleoptera, Hemiptera, Homoptera, and Scorpionida.
[5]58.0%; Diptera, Hexapoda, Coleoptera, Psocoptera, Araneae, Lepidoptera, Scorpionida, and Isoptera.
[6]56.6%; lizards, Orthoptera, Scorpionida, and Solifugae.

tance, the variables separating years were Gryllacrididae, Acanalonidae, Coleoptera, Coreidae, Hemiptera, Cydnidae, Curculionidae, Orthoptera, and Lepidoptera. This analysis indicated there was some variation between years. However, most of the variability was in food categories that were incidental (occurred at very low frequencies) or that were abundant during only one or two of the four years. The major food categories occurred every year, but fluctuated in frequency and total number of items observed.

Discriminant analysis was performed between months (May through August) combining sexes and data for 1977 through 1979 (Table 2); 51% of the specimens were classified correctly. Using all arthropod taxa, 64% were classified correctly. Variables contributing the most to the classification were lizards (juvenile *Phrynosoma*), Termitidae, Scorpionida, Coleoptera, Asilidae, Psocoptera, and Elateridae. These analyses showed some variation between months, but most of the variability was associated with incidentally occurring food categories.

When months were considered for individual years, discriminant analyses using arthropod orders as characters showed greater differences between months than when data were combined (Table 2). Analyses using all arthropod taxa correctly classified 88, 75, and 72% of specimens to month for 1977, 1978, and 1979, respectively. For 1977 variables accounting for the most differences were Hymenoptera, Sphingidae, Cicadellidae, Lepidoptera, Acrididae, Coleoptera, and Elateridae. For 1978 Mantidae, Curculionidae, Isoptera, Gryllacrididae, Elateridae, Psocoptera, and Gryllidae accounted for the most differences. For 1979 variables accounting for the most differences between months were lizards, Acrididae, Pentatomidae, Geometridae, Blattoidea, Lepidoptera, and Tenebrionidae. For each of the three years, the separa-

TABLE 3. Discriminant analyses between sexes for *Cnemidophorus tigris*.

	Actual group	n	Predicted group membership	
			Male	Female
1978–1979[1,2]	Male	64	51(79.7%)	13(20.3%)
	Female	58	22(37.9%)	36(62.1%)
1978[3]	Male	37	34(91.9%)	3(8.1%)
	Female	32	11(34.4%)	21(65.6%)
1979[4]	Male	27	20(74.1%)	7(25.9%)
	Female	26	6(23.1%)	20(76.9%)
May 1978[5]	Male	9	9(100%)	0
	Female	5	1(20.0%)	4(80.0%)
June 1978[6]	Male	13	12(92.3%)	1(7.7%)
	Female	13	2(15.4%)	11(84.6%)
July 1978[7]	Male	11	10(90.9%)	1(9.1%)
	Female	9	2(22.2%)	7(77.8%)
August 1978[8]	Male	4	4(100%)	0
	Female	5	0	5(100%)
May 1979[9]	Male	5	5(100%)	0
	Female	3	0	3(100%)
June 1979[10]	Male	12	12(100%)	0
	Female	8	0	8(100%)
July 1979[11]	Male	6	4(66.7%)	2(33.3%)
	Female	14	2(14.3%)	12(85.7%)

[1]The data in subsequent footnotes are given as: percent of the specimens that were correctly classified, in decreasing order of importance, the variables accounting for most or all of the differences.
[2]71.3%; Neuroptera, Hemiptera, Orthoptera, Coleoptera, Isoptera, Solifugae, Psocoptera, Araneae, Scorpionida, and lizards.
[3]79.7%; Neuroptera, Solifugae, Orthoptera, Psocoptera, Isoptera, and Hexapoda.
[4]75.5%; Hemiptera, Lepidoptera, Orthoptera, sand, Solifugae, Coleoptera, Araneae, and Isoptera.
[5]92.9%; Neuroptera, Solifugae, Homoptera, and Coleoptera.
[6]88.5%; Neuroptera, Isoptera, Coleoptera, Solifugae, Orthoptera, Hemiptera, Diptera, Hexapoda, and Scorpionida.
[7]85.0%; Neuroptera, Hemiptera, Solifugae, Homoptera, and Araneae.
[8]100%; Coleoptera, Isoptera, Homoptera, Orthoptera, and Neuroptera.
[9]100%; Scorpionida, Araneae, and Coleoptera.
[10]100%; Hymenoptera, Isoptera, Neuroptera, Hemiptera, Lepidoptera, Coleoptera, insect eggs, Scorpionida, Diptera, and sand.
[11]80.0%; Araneae, Hymenoptera, and Arthropoda.

tion of months was primarily based upon incidental occurrences. Thus, monthly-seasonal variation was evident but was mostly reflected by incidentally occurring food categories. This was the same type of variation observed between years.

The sex of each lizard was determined in 1978 and 1979, and discriminant analyses were used to assess sexual variation for these years. When 1978 and 1979 males were combined and compared to females, there were differences between sexes (Table 3). Except for Hemiptera, Solifugae, and Psocoptera, food categories accounting for the most differences were represented in both sexes (Table 4). Analysis using all arthropod taxa provided 79% correct classifications; Myrmeleontidae, Isoptera, Noctuidae, Hymenoptera, Solifugae, Psocoptera, Araneae, Scorpionida, and Rhopalidae contributed the most to the differences. Of these, Myrmeleontidae, Isoptera, and Araneae were the most consistently occurring food categories.

Each year was then examined separately. For 1978, 80% of the lizards were classified correctly to sex (Table 3). Psocoptera and Hexapoda were the only variables accounting for differences that could be considered as incidental (Table 4). Considering all arthropod taxa, 90% were classified correctly, and Myrmeleontidae, Solifugae, Tettigoniidae, Hymenoptera, Cicadellidae, Psocoptera, and Elateridae accounted for the differences. Of these, Myrmeleontidae, Solifugae, and Tettigoniidae were the only consistently occurring food categories. For 1979, 76% of the specimens were classified correctly (Table 3). Except for Hemiptera, sand, and Solifugae, the variables accounting for the differences represented some of the most consistently occurring food categories (Table 4). Eighty-three percent of the lizards

TABLE 4. Food items in *Cnemidophorus tigris* collected during 1978 and 1979. See Table 1 for data presentation format.

Food category	Year and month of collection 1978									
	May (14)		June (26)		July (20)		August (9)		Total (69)	
	♂♂ (9)	♀♀ (5)	♂♂ (13)	♀♀ (13)	♂♂ (11)	♀♀ (9)	♂♂ (4)	♀♀ (5)	♂♂ (37)	♀♀ (32)
ARACHNIDA										
Scorpionida	1;1	1;1	1;1	4;4					2;2	5;5
Araneae	2;3	2;2	3;4	4;7		1;1	1;1		6;8	7;10
Solifugae		2;2		2;3		2;2	1;1	1;1	1;1	7;8
HEXAPODA	1;1		2;3	1;1					3;4	1;1
Orthoptera (6)	6;9	5;19	11;27	12;37	9;16	9;16	4;9	5;13	30;61	31;85
Isoptera (3)	2;10		3;7	5;95	2;37	3;139	1;48	3;173	8;102	11;407
Psocoptera (1)	1;1						1;1		2;2	
Hemiptera (1)			1;1			1;1			1;1	1;1
Homoptera (3)		1;2				2;6		2;2		5;10
Neuroptera (2)		2;3	2;2	6;15	1;1	4;4	1;1	3;3	4;4	15;25
Coleoptera (6)	6;21	4;9	9;21	6;12	4;8	6;10		3;4	19;50	19;35
Lepidoptera (3)	2;10	2;4	6;15	7;14	2;4	1;1			10;29	10;19
Diptera (1)	1;1		1;2	1;1			1;1	3;3	3;4	4;4
Hymenoptera (3)	2;2	3;3	3;11	3;3	1;1	1;1	1;1	2;2	7;15	9;9

Food category	1979									
	May (8)		June (20)		July (20)		August (5)		Total (53)	
	♂♂ (5)	♀♀ (3)	♂♂ (12)	♀♀ (8)	♂♂ (6)	♀♀ (14)	♂♂ (4)	♀♀ (1)	♂♂ (27)	♀♀ (26)
Arthropoda					1;1				1;1	
ARACHNIDA					1;1				1;1	
Scorpionida		2;2		2;2			1;1		1;1	4;4
Araneae	1;1	1;1	1;1	2;2		7;10	1;2		3;4	10;13
Solifugae			3;3						3;3	
HEXAPODA										
Orthoptera (5)	4;6	2;6	10;14	7;13	5;8	13;23	4;9	1;3	23;37	23;45
Isoptera (2)		1;57	4;22	6;195	3;42	6;84	3;87		10;151	13;336
Hemiptera (3)		2;2		2;2		1;1				5;5
Homoptera (1)			1;1						1;1	
Neuroptera (1)		1;1		1;1		1;2	1;1		1;1	3;4
Coleoptera (4)	2;2		3;3	1;4	2;3	3;5	2;3		9;11	4;9
Lepidoptera (3)	1;1	2;4	2;3	3;3	2;2	5;9			5;6	10;16
Diptera (1)			1;1			1;1			1;1	1;1
Hymenoptera (2)	1;1		1;1	4;6	3;5	5;6	2;3		7;10	9;12
MISCELLANEOUS										
Insect eggs				1;18						1;18
Lizards							2;2		2;2	
Sand			2;2						2;2	
Empty stomachs	1;1								1;1	

were classified correctly using all arthropod taxa. In decreasing order of importance, the variables contributing the most to the differences were Araneae, lizards, Scorpionida, Sphingidae, Rhopalidae, Solifugae, Acrididae, and Polyphagidae. Only Araneae and Acrididae occurred with consistency between sexes for 1979. The degree of sexual differences between years were similar (Table 3).

Subsequent analyses concentrated on the differences between sexes for each monthly sample during 1978 and 1979. For May 1978, 93% of the specimens were classified correctly to sex (Table 3). Of the variables accounting for the differences, only Coleoptera were found in both sexes; the others were in females only (Table 4). When all arthropod taxa were considered, 93% of the specimens were classified correctly, with Solifugae, Myrmeleontidae, and Cicadellidae accounting for the differences. All of these occurred in females only. For June 1978, 89% of the specimens were classified correctly to sex (Table 3). Of the variables accounting for the differences, all except Solifugae and Hemiptera were present in both sexes (Table 4). Using all arthropod taxa, 96% of the specimens were classified correctly, with Myrmeleontidae, Solifugae, Isoptera, Tenebrionidae, Scorpionida, Araneae, Hymenoptera, and Coleoptera accounting for the most differences. Solifugae, Hymenoptera, and Coleoptera occurred in females only, and the others were found in both sexes. For July 1978, 85% of the specimens were classified correctly to sex (Table 3). Of the variables accounting for the differences, all but Neuroptera occurred in females only (Table 4). Using all arthropod taxa, 90% were classified correctly, with Elateridae, Solifugae, Termitidae, Tettigoniidae, Myrmeleontidae, and Noctuidae accounting for the differences. Except for Myrmeleontidae, all of these variables occurred in female stomachs only. The August 1978 analysis correctly classified 100% of the lizards to sex (Table 3). Coleoptera and Homoptera were found in females only (Table 4). Considering all arthropod taxa, 100% were classified correctly with Coccoidea, Termitidae, Gryllidae, Scarabaeidae, Myrmeleontidae, and Asilidae accounting for the differences. Myrmeleontidae and Asilidae were in both sexes, and the others were in females only.

For May 1979, 100% of the specimens were classified correctly to sex (Table 3). Of the three variables accounting for the differences, only Araneae was found in both sexes (Table 4). When all arthropod taxa were used in the analysis, 100% of the specimens were classified correctly. The variables accounting for the differences were Pentatomidae, Geometridae, and Araneae. Pentatomidae occurred in males only, and the other two were in both sexes. For June 1979, 100% of the specimens were classified correctly to sex (Table 3). Of the variables accounting for the most differences, only Hymenoptera, Isoptera, Lepidoptera, and Coleoptera occurred in both sexes (Table 4). Considering all arthropod taxa, 100% of the lizards were classified correctly. In decreasing order of importance, variables accounting for the differences were Isoptera, Sphingidae, Termitidae, Rhopalidae, Myrmeleontidae, Formicidae, Scorpionida, and Blattidae. None of these occurred in both sexes. For July 1979, 80% of the lizards were classified correctly (Table 3). Of the three variables accounting for the differences, only Hymenoptera was present in both sexes (Table 4). Considering all arthropod taxa, 85% of the specimens were classified correctly, with Araneae, Elateridae, Arthropoda, Formicidae, and Lepidoptera accounting for the differences between sexes. Elateridae, Formicidae, and Lepidoptera occurred in both sexes. Because of the small sample for August 1979, discriminant analyses were not performed.

Discussion

In his examination of geographic variation in the diet of *C. tigris*, Pianka (1970) found the same major food items as in previous studies, but there was a pronounced latitudinal shift in diet. His southern lizards consumed large numbers of termites, but northern lizards relied on other foods. He indicated that this could possibly be because there were simply fewer termites in his Great Basin flatland desert habitats. Additionally, Pianka (1970) observed that food species diversities reflected the latitudinal change in diet. Our results were similar to previous studies in that Orthoptera, Coleoptera, Isoptera, and Lepidoptera were among the most abundant food categories. The diversity of food categories found in our specimens is as great or greater than any of the previous *C. tigris* food habit studies. This may indicate a greater diversity of food organisms was available for consumption by our lizards, that a greater diversity was taken by our lizards, that there were varying degrees of expertise in identifying the stomach contents, or that different taxonomic levels have been used in identifying the food categories.

Several previous investigators have noted the presence of annual diet variation in *C. tigris* (Milstead 1965, Medica 1967, Milstead and Tinkle 1969, Mitchell 1979). Our findings also indicated some annual variation was present. However, the differences we found between years were primarily the result of incidentally occurring food categories. The consistency of the major food categories between years indicated that *C. tigris* was not a completely opportunistic feeder. The species takes certain arthropod taxa very regularly from year to year (i.e., Orthoptera, Coleoptera, Isoptera, and Lepidoptera) and is opportunistic only in the sense of taking other taxa that may fall into, for example, the proper size, taste, or behavioral category. *Cnemidophorus tigris* takes foods within its normal "requirements" in greater abundance when they are available in greater abundance. We believe a completely opportunistically feeding species is one that takes food as it more or less randomly encounters it, such as is done by coyotes (e.g., Best et al. 1981). The consistency of various food categories in the diet of *C. tigris* indicated that some selection must have been taking place. From Best and Gennaro's (1984) study of *Uta stansburiana* on the same study area, we know that large numbers of ants (Formicidae) and true bugs (Hemiptera) were also available as food items. However, possibly because of different foraging habits (e.g., Milstead 1957b, Pianka 1970, Vitt and Ohmart 1977, Parker and Pianka 1977) or selection of foods, ants and certain other arthropods were rarely found in *C. tigris* stomachs. During times of environmental adversity, we expect that *C. tigris* would take food species that may not be "preferred" just to survive.

The presence of seasonal variation in the diet of *C. tigris* has been addressed by some previous workers (Johnson 1966, Milstead and Tinkle 1969, Pianka 1970, Vitt and Ohmart 1977, Mitchell 1979). We found varying degrees of separation between months. This seasonal variation was probably caused by the taking of a variety of temporarily abundant arthropods as the growing seasons progressed. In the Chihuahuan desert of south central New Mexico the seasonal rainfall pattern as well as total amount of rainfall affects the primary productivity and hence the availability of arthropods as foods for lizards (Whitford and Creusere 1977).

Sexual differences in diet of *C. tigris* have been examined by Johnson (1966) and Pianka (1970). They noted there were only slight differences between sexes. Our data from southeastern New Mexico indicated there was a great deal of difference between sexes. Sexual differences have also been shown for *Anolis* (Schoener 1967, 1968); they differed dramatically in size and ate quite different foods. Sexual differences have been found in *U. stansburiana* (Parker and Pianka 1977, Best and Gennaro 1984). Best and Gennaro (1984) postulated these differences may be related to secondary sexual size dimorphism. Since *C. tigris* also shows secondary sexual size dimorphism (e.g., Medica 1967), we expect that the sexual diet differences reported herein may also be related to size variation. Diet differences between sexes would act to reduce intersexual competition for food resources—an adaptation that is known for other vertebrates (e.g., birds, Selander 1966).

Our study of the feeding ecology of *C. tigris* in southeastern New Mexico has shown the presence of a small amount of annual and seasonal variation, and a considerable amount of sexual variation. The annual and seasonal variation was attributed to the temporary abundance of a variety of arthropod taxa that were taken as available. Sexual differences in diet were possibly related to differences in secondary sexual size dimorphism and may be acting to reduce intraspecific competition for food in the semidesert environment of southeastern New Mexico.

Acknowledgments

We thank J. C. Schaffner, Texas A&M University, and N. Jorgensen, Eastern New Mexico University, for identifying the stomach contents. B. Hoditschek, P. J. Polechla, and numerous other graduate student assistants aided in specimen collection and data preparation. This project was funded as a portion of the Los Medaños Waste Isolation Pilot Plant studies by Sandia National Laboratories (Contract 13-2097) and Westinghouse Electric Corp. (Subcontract WFC-53431-SD). S. A. Cole assisted in proofreading, and N. J. Scott, Jr., S. Neuhauser, and D. J. Hafner critically reviewed the manuscript.

Literature Cited

Best, T. L., and D. W. Jackson. 1982. Statistical evaluation of plant density data collected at the Los Medaños site, New Mexico (1978–1980), xi+374 pp. *In* Braswell, J., and J. S. Hart, eds., Ecosystem studies at the Los Medaños site, Eddy County, New Mexico. U.S. Dept. Energy, Albuquerque, New Mexico, TME 3141, 3 vols., 982+ pp.

Best, T. L., and A. L. Gennaro. 1984. Feeding ecology of the lizard *Uta stansburiana* in southeastern New Mexico. J. Herpetol. 18:291–301.

BEST, T. L., B. HODITSCHEK, AND H. H. THOMAS. 1981. Foods of coyotes (*Canis latrans*) in Oklahoma. Southwest. Nat. 26:67–69.

BEST, T. L., AND P. J. POLECHLA. 1983. Foods of the Texas spotted whiptail lizard (*Cnemidophorus gularis*) in New Mexico. Southwest. Nat. 23:376–377.

BICKHAM, J. W., AND J. A. MACMAHON. 1972. Feeding habits of the western whiptail lizard, *Cnemidophorus tigris*. Southwest. Nat. 17:207–208.

BORROR, D. J., D. M. DELONG, AND C. A. TRIPLEHORN. 1981. An introduction to the study of insects. Saunders College Publ., New York. xi+827 pp.

ECHTERNACHT, A. C. 1967. Ecological relationships of two species of the lizard genus *Cnemidophorus* in the Santa Rita Mountains of Arizona. Amer. Midl. Nat. 78:448–459.

JOHNSON, D. R. 1966. Diet and estimated energy assimilation of three Colorado lizards. Amer. Midl. Nat. 76:504–509.

MEDICA, P. A. 1967. Food habits, habitat preference, reproduction, and diurnal activity in four sympatric species of whiptail lizards (*Cnemidophorus*) in south central New Mexico. Bull. So. California Acad. Sci. 66:251–276.

MILSTEAD, W. W. 1957a. Some aspects of competition in natural populations of whiptail lizards (genus *Cnemidophorus*). Texas J. Sci. 9:410–447.

______. 1957b. Observations on the natural history of four species of whiptail lizard, *Cnemidophorus* (Sauria, Teiidae) in Trans-Pecos Texas. Southwest. Nat. 2:105–121.

______. 1958. A list of the arthropods found in the stomachs of whiptail lizards from four stations in southwestern Texas. Texas J. Sci. 10:443–446.

______. 1961. Competitive relations in lizard populations. Pages 460–489 *in* Blair, W. F., ed., Vertebrate speciation. University of Texas Press, Austin, 642 pp.

______. 1965. Changes in competing populations of whiptail lizards (*Cnemidophorus*) in southwestern Texas. Amer. Midl. Nat. 73:75–80.

MILSTEAD, W. W., AND D. W. TINKLE. 1969. Interrelationships of feeding habits in a population of lizards in southwestern Texas. Amer. Midl. Nat. 81:491–499.

MITCHELL, J. C. 1979. Ecology of southeastern Arizona whiptail lizards (*Cnemidophorus:* Teiidae). Population densities, resource partitioning, and niche overlap. Canad. J. Zool. 57:1487–1499.

NIE, N. H., C. H. HULL, J. G. JENKINS, K. STEINBRENNER, AND D. H. BENT. 1975. Statistical package for the social sciences (SPSS). McGraw-Hill Book Co., New York. 675 pp.

PACK, H. J. 1923. The food habits of *Cnemidophorus tessellatus tessellatus* (Say). Proc. Biol. Soc. Washington 36:85–90.

PARKER, W. S., AND E. R. PIANKA. 1975. Comparative ecology of populations of the lizard *Uta stansburiana*. Copeia 1975:615–632.

PIANKA, E. R. 1970. Comparative autecology of the lizard *Cnemidophorus tigris* in different parts of its geographic range. Ecology 51:703–720.

SCHOENER, T. W. 1967. The ecological significance of sexual dimorphism in size in the lizard *Anolis conspersus*. Science 155:474–477.

______. 1968. The *Anolis* lizards of Bimini: Resource partitioning in a complex fauna. Ecology 49:704–726.

SCUDDAY, J. F., AND J. R. DIXON. 1973. Diet and feeding behavior of teiid lizards from Trans-Pecos, Texas. Southwest. Nat. 18:279–289.

SELANDER, R. K. 1966. Sexual dimorphism and differential niche utilization in birds. Condor 68:113–151.

VITT, L. J., AND R. D. OHMART. 1977. Ecology and reproduction of lower Colorado River lizards: II. *Cnemidophorus tigris* (Teiidae) with comparisons. Herpetologica 33:223–234.

WHITFORD, W. G., AND F. M. CREUSERE. 1977. Seasonal and yearly fluctuations in Chihuahuan desert lizard communities. Herpetologica 33:54–65.